IBM Flex System x440 Compute Node

IBM Redbooks Product Guide

A building block for the IBM® PureFlex™ System family, the IBM Flex System™ x440 Compute Node is a four-socket Intel Xeon processor-based server optimized for high-end virtualization, mainstream database deployments, and memory-intensive high performance environments. It is price-performance optimized with a wide range of processors, memory, and I/O options to help you match system capabilities and cost to workloads without compromise. With a dense design, the Flex System x440 Compute Node can help reduce floor space used, and lower data center power and cooling costs.

Suggested usage: Database, virtualization, and enterprise applications.

Figure 1 shows the IBM Flex System x440 Compute Node.

Figure 1. The IBM Flex System x440 Compute Node

Did you know?

IBM Flex System is a new category of computing that integrates multiple server architectures, networking, storage, and system management capability into a single system that is easy to deploy and manage. IBM Flex System has full, built-in virtualization support of servers, storage, and networking to speed provisioning and increased resiliency. In addition, it supports open industry standards, such as operating systems, networking and storage fabrics, virtualization, and system management protocols, to easily fit within existing and future data center environments. IBM Flex System is scalable and extendable with multi-generation upgrades to protect and maximize IT investments.

Key features

This section describes the key features of the compute node.

Scalability and performance

The x440 offers numerous features to boost performance, improve scalability, and reduce costs:

- The Intel Xeon processor E5-4600 product family improves productivity by offering superior system performance with 8-core processors and up to 2.9 GHz core speeds, up to 20 MB of L3 cache, and up to two 8 GTps QPI interconnect links.
- Up to four processors, 32 cores, and 64 threads maximize the concurrent execution of multithreaded applications.
- Intelligent and adaptive system performance with Intel Turbo Boost Technology 2.0 allows processor cores to run at maximum speeds during peak workloads by temporarily going beyond processor thermal design power (TDP).
- Intel Hyper-Threading Technology boosts performance for multithreaded applications by enabling simultaneous multithreading within each processor core, up to two threads per core.
- Intel Virtualization Technology integrates hardware-level virtualization hooks that allow operating system vendors to better use the hardware for virtualization workloads.
- Intel Advanced Vector Extensions (AVX) improve floating-point performance for compute-intensive technical and scientific applications compared to Intel Xeon 5600 series processors.
- Up to 48 DDR3 ECC memory RDIMMs provide speeds up to 1600 MHz and a memory capacity of up to 768 GB. Load-reduced DIMMs (LRDIMMs) are supported with a maximum capacity of 1.5 TB of memory.
- The use of solid-state drives (SSDs) instead of or along with traditional hard disk drives (HDDs) can significantly improve I/O performance. An SSD can support up to 100 times more I/O operations per second (IOPS) than a typical HDD.
- Up to 32 virtual I/O ports per compute node with integrated 10 Gb Ethernet ports, offering the choice of Ethernet, Fibre Channel, iSCSI, or FCoE connectivity. With models without integrated 10 Gb ports, you can have up to 64 virtual I/O ports by installing four CN4054 10Gb Virtual Fabric Adapters.
- The x440 offers PCI Express 3.0 I/O expansion capabilities that improve the theoretical maximum bandwidth by 60% (8 GTps per link), compared with the previous generation of PCI Express 2.0.
- With Intel Integrated I/O Technology, the PCI Express 3.0 controller is integrated into the Intel Xeon processor E5 family. This configuration reduces I/O latency and increases overall system performance.
- Support for high-bandwidth I/O adapters, up to four in each x440 Compute Node. Support for 10 Gb Ethernet, 16 Gb Fibre Channel, and FDR InfiniBand.

Availability and serviceability

The x440 provides many features to simplify serviceability and increase system uptime:

- Chipkill, memory mirroring, and memory rank sparing for redundancy in the event of a non-correctable memory failure.
- Tool-less cover removal provides easy access to upgrades and serviceable parts, such as processor, memory, and adapter cards.
- Hot-swap drives supporting integrated RAID 1 redundancy for data protection and greater system uptime.

- A light path diagnostics panel and individual light path LEDs to quickly lead the technician to failed (or failing) components. This panel simplifies servicing, speeds up problem resolution, and helps improve system availability.
- Predictive Failure Analysis (PFA), which detects when system components (such as processors, memory, and hard disk drives) operate outside of standard thresholds and generates proactive alerts in advance of possible failure, therefore increasing uptime.
- Solid-state drives (SSDs), which offer better reliability than traditional mechanical HDDs for greater uptime.
- Built-in Integrated Management Module II (IMM2) continuously monitors system parameters, triggers alerts, and performs recovering actions in case of failures to minimize downtime.
- Built-in diagnostics using Dynamic Systems Analysis (DSA) Preboot speeds up troubleshooting tasks to reduce service time.
- Three-year customer replaceable unit and on-site limited warranty, next business day 9x5. Optional service upgrades are available.

Manageability and security

Powerful systems management features simplify local and remote management of the x440:

- The x440 includes an Integrated Management Module II (IMM2) to monitor server availability and perform remote management.
- An integrated industry-standard Unified Extensible Firmware Interface (UEFI) enables improved setup, configuration, and updates, and simplifies error handling.
- Integrated Trusted Platform Module (TPM) V1.2 support enables advanced cryptographic functionality, such as digital signatures and remote attestation.
- Industry-standard AES NI support for faster and stronger encryption.
- Integrates with the IBM Flex System Manager for proactive systems management. It offers comprehensive systems management for the entire IBM Flex System platform, which increases uptime, reduces costs, and improves productivity through advanced server management capabilities.
- IBM Fabric Manager simplifies the deployment of infrastructure connections by managing network and storage address assignments.
- Intel Execute Disable Bit functionality can prevent certain classes of malicious buffer overflow attacks when combined with a supporting operating system.
- Intel Trusted Execution Technology provides enhanced security through hardware-based resistance to malicious software attacks, allowing an application to run in its own isolated space protected from all other software running on a system.

Energy efficiency

The x440 offers the following energy-efficiency features to save energy, reduce operational costs, increase energy availability, and contribute to a green environment:

- Component-sharing design of the IBM Flex System chassis provides ultimate power and cooling savings.
- The Intel Xeon processor E5-4600 product family offers better performance over the previous generation while fitting into the same TDP limits.
- Intel Intelligent Power Capability powers individual processor elements on and off as needed, to reduce power draw.

- Low-voltage Intel Xeon processors draw less energy to satisfy demands of power and thermally constrained data centers and telecommunication environments.
- Low-voltage 1.35 V DDR3 memory RDIMMs consume 15% less energy than 1.5 V DDR3 RDIMMs.
- SSDs consume as much as 80% less power than traditional spinning 2.5-inch HDDs.
- The x440 uses hexagonal ventilation holes, a part of IBM Calibrated Vectored Cooling™ technology. Hexagonal holes can be grouped more densely than round holes, providing more efficient airflow through the system.

Locations of key components and connectors

Figure 2 shows the front of the server.

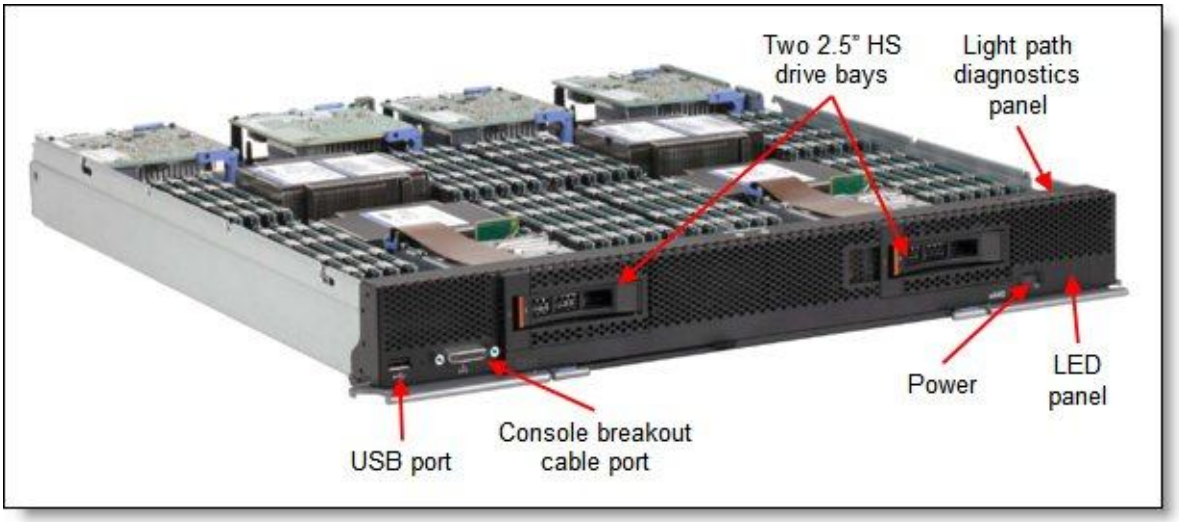

Figure 2. Front view of the IBM Flex System x440 Compute Node

Figure 3 shows the locations of key components inside the server.

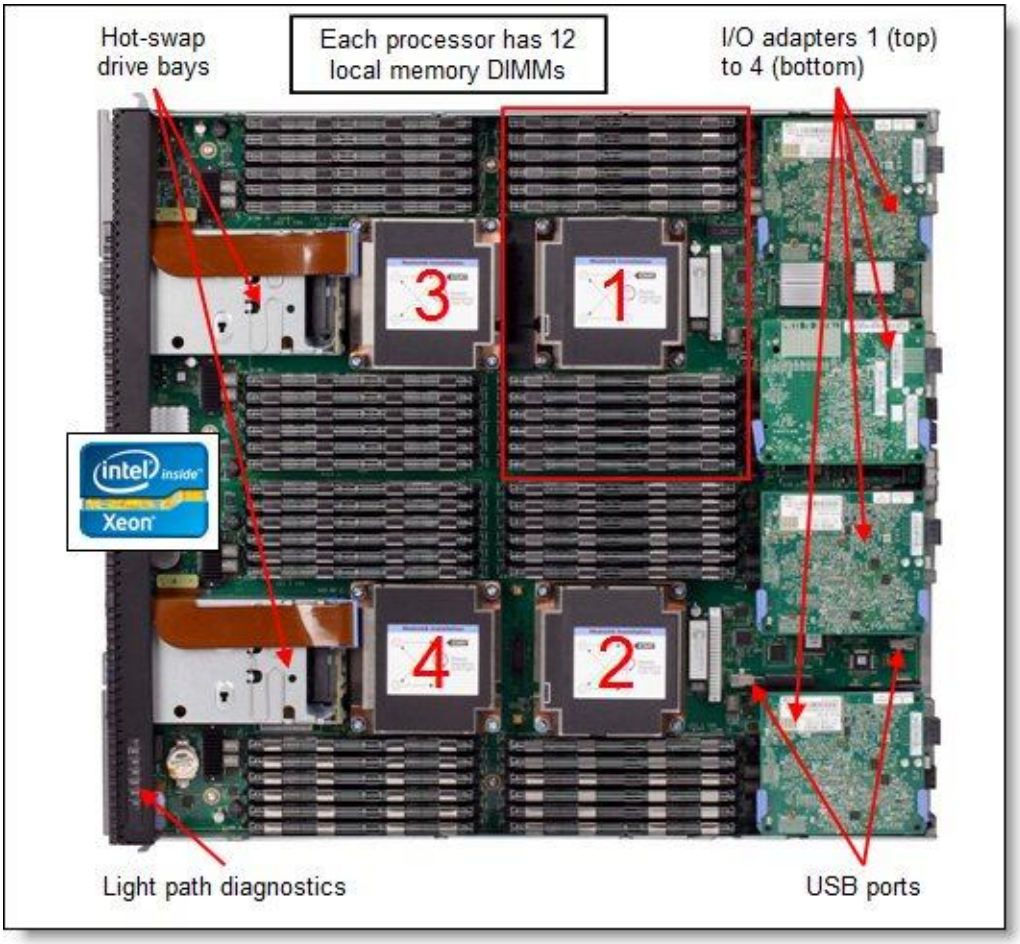

Figure 3. Inside view of the IBM Flex System x440 Compute Node

Standard specifications

The following table lists the standard specifications.

Table 1. Standard specifications (part 1)

Components	Specification
Form factor	Double-wide compute node.
Chassis support	IBM Flex System Enterprise Chassis.
Processor	Up to four Intel Xeon processor E5-4600 product family processors, each with eight cores (up to 2.7 GHz), six cores (up to 2.9 GHz), or four cores (up to 2.0 GHz). Two QPI links, up to 8.0 GTps each. Up to 1600 MHz memory speed. Up to 20 MB L3 cache per processor.
Chipset	Intel C600 series.
Memory	Up to 48 DIMM sockets (12 DIMMs per processor) using Low Profile (LP) DDR3 DIMMs. UDIMMs, RDIMMs and LRDIMMs supported. 1.5 V and low-voltage 1.35 V DIMMs are supported. Support for up to 1600 MHz memory speed, depending on the processor. Four memory channels per processor (three DIMMs per channel). Supports two DIMMs per channel operating at 1600 MHz (2 DPC @ 1600MHz) with single and dual-rank RDIMMs. Supports three DIMMs per channel at 1066 MHz with single and dual-rank RDIMMs.
Memory maximums	With LRDIMMs: Up to 1.5 TB with 48x 32 GB LRDIMMs and four processors. With RDIMMs: Up to 768 GB with 48x 16 GB RDIMMs and four processors. With UDIMMs: Up to 128 GB of 32x 4 GB UDIMMs and four processors
Memory protection	ECC, Chipkill (for x4-based memory DIMMs), memory mirroring, and memory rank sparing.
Disk drive bays	Two 2.5-inch hot-swap SAS/SATA drive bays supporting SAS, SATA, and SSD drives. Optional Flash Kit support for up to eight 1.8-inch SSDs.
Maximum internal storage	With two 2.5-inch hot-swap drives: Up to 2 TB with 1 TB 2.5" NL SAS HDDs, or up to 1.8 TB with 900 GB 2.5" SAS HDDs, or up to 2 TB with 1 TB 2.5" SATA HDDs, or up to 512 GB with 256 GB 2.5" SATA SSDs. Intermix of SAS and SATA HDDs and SSDs is supported. With 1.8-inch SSDs and ServeRAID M5115 RAID adapter: Up to 1.6 TB with eight 200 GB 1.8-inch SSDs.
RAID support	RAID 0 and 1 with integrated LSI SAS2004 controller. Optional ServeRAID M5115 RAID controller with RAID 0, 1, 10, 5, and 50 support and 1 GB cache. Supports up to eight 1.8-inch SSDs with expansion kits. Optional flash-backup for cache, RAID 6/60, and SSD performance enabler.
Network interfaces	x4x models: Four 10 Gb Ethernet ports with two dual-port Embedded 10Gb Virtual Fabric Ethernet LAN-on-motherboard (LOM) controllers; Emulex BE3 based. Upgradeable to FCoE and iSCSI using IBM Feature on Demand license activation. x2x models: None standard; optional 1 Gb or 10 Gb Ethernet adapters.
PCI Expansion slots	Four I/O connectors for adapters. PCI Express 3.0 x16 interface. I/O slots 3 and 4 require the second processor installed.
Ports	USB ports: One external. Two internal for embedded hypervisor. Console breakout cable port providing local KVM and serial ports (cable standard with chassis; additional cables optional).
Systems management	UEFI, IBM Integrated Management Module 2 (IMM2) with Renesas SH7757 controller, Predictive Failure Analysis, light path diagnostics panel, automatic server restart, and remote presence. Support for IBM Flex System Manager, IBM Systems Director, and IBM ServerGuide.

Table 1. Standard specifications (part 2)

Components	Specification
Security features	Power-on password and administrator's password, Trusted Platform Module 1.2.
Video	Matrox G200eR2 video core with 16 MB video memory integrated into the IMM2. Maximum resolution is 1600x1200 at 75 Hz with 16 M colors.
Limited warranty	Three-year customer-replaceable unit and on-site limited warranty with 9x5/NBD.
Operating systems supported	Microsoft Windows Server 2008 R2 and 2012, Red Hat Enterprise Linux 5 and 6, SUSE Linux Enterprise Server 10 and 11, VMware ESX 4.1, 5.0 and 5.1. See "Supported operating systems" for details.
Service and support	Optional service upgrades are available through the IBM ServicePac® feature: Four-hour or 2-hour response time, 8-hour fix time, 1-year or 2-year warranty extension, remote technical support for IBM hardware and selected IBM and OEM software.
Dimensions	Width: 437 mm (17.2 inches), height 51 mm (2.0 inches), depth 493 mm (19.4 inches)
Weight	Maximum weight: 12.25 kg (27 lbs)

The x440 servers are shipped with the following items:

- Statement of Limited Warranty
- Important Notices
- Documentation CD that contains the *Installation and Service Guide*

Standard models

The following table lists the standard models.

Table 2. Standard models

Model	Intel Xeon processor (4 maximum)**	Memory	Disk adapter	Disk bays (used/max)†	Disks	10 GbE Embedded Virtual Fabric‡	I/O slots (used/max)
7917-A2x	Xeon E5-4603 4C 2.0 GHz 10 MB 1066 MHz 95W	1x 8 GB 1066 MHz*	SAS/SATA RAID	2.5” hot-swap (0 / 2)	Open	No	0 / 4
7917-A4x	Xeon E5-4603 4C 2.0 GHz 10 MB 1066 MHz 95W	1x 8 GB 1066 MHz*	SAS/SATA RAID	2.5” hot-swap (0 / 2)	Open	Standard	2 / 4‡
7917-B2x	Xeon E5-4607 6C 2.2 GHz 12 MB 1066 MHz 95W	1x 8 GB 1066 MHz*	SAS/SATA RAID	2.5” hot-swap (0 / 2)	Open	No	0 / 4
7917-B4x	Xeon E5-4607 6C 2.2 GHz 12 MB 1066 MHz 95W	1x 8 GB 1066 MHz*	SAS/SATA RAID	2.5” hot-swap (0 / 2)	Open	Standard	2 / 4‡
7917-C2x	Xeon E5-4610 6C 2.4 GHz 15 MB 1333 MHz 95W	1x 8 GB 1333 MHz	SAS/SATA RAID	2.5” hot-swap (0 / 2)	Open	No	0 / 4
7917-C4x	Xeon E5-4610 6C 2.4 GHz 15 MB 1333 MHz 95W	1x 8 GB 1333 MHz	SAS/SATA RAID	2.5” hot-swap (0 / 2)	Open	Standard	2 / 4‡
7917-D2x	Xeon E5-4620 8C 2.2 GHz 16 MB 1333 MHz 95W	1x 8 GB 1333 MHz	SAS/SATA RAID	2.5” hot-swap (0 / 2)	Open	No	0 / 4
7917-D4x	Xeon E5-4620 8C 2.2 GHz 16 MB 1333 MHz 95W	1x 8 GB 1333 MHz	SAS/SATA RAID	2.5” hot-swap (0 / 2)	Open	Standard	2 / 4‡
7917-F2x	Xeon E5-4650 8C 2.7 GHz 20 MB 1600 MHz 130W	1x 8 GB 1600 MHz	SAS/SATA RAID	2.5” hot-swap (0 / 2)	Open	No	0 / 4
7917-F4x	Xeon E5-4650 8C 2.7 GHz 20 MB 1600 MHz 130W	1x 8 GB 1600 MHz	SAS/SATA RAID	2.5” hot-swap (0 / 2)	Open	Standard	2 / 4‡

** Processor detail: Processor quantity and model, cores, core speed, L3 cache, memory speed, and power consumption.
* For models Axx and Bxx, the standard DIMM is rated at 1333 MHz, but operates at up to 1066 MHz to match the processor memory speed.
† The 2.5-inch drive bays can be replaced and expanded with additional internal bays to support up to eight 1.8-inch solid-state drives (SSDs). See the "Internal disk storage options" section.
‡ The x4x models include two Embedded 10Gb Virtual Fabric Ethernet controllers. Connections are routed using a Fabric Connector. The Fabric Connectors preclude the use of an I/O adapter in I/O connectors 1 and 3, except the ServeRAID M5115 controller, which can be installed in slot 1.

Chassis support

The x440 is supported in the IBM Flex System Enterprise Chassis.

Processor options

The x440 supports the processor options listed in the following table. The server supports one or two or four processors (three processors is not supported). For a given processor model (for example, the Xeon E5-4603), there are two part numbers: the first one is for the rear two processors (CPUs 1 and 2) and include taller heat sinks; the second part number is for the front two processors (CPUs 3 and 4) and include shorter heat sinks.

The table also shows which server models have each processor standard. If no corresponding *where used* model for a particular processor is listed, then this processor is available only through Configure to Order (CTO).

Table 3. Processor options

Part number	Feature code*	Intel Xeon processor description	CPUs 1 & 2	CPUs 3 & 4	Models where used
90Y9060	A2C0 / A2C2	Xeon E5-4603 4C 2.0GHz 10MB 1066MHz 95W	Yes	No	A2x and A4x
88Y6263	A2C1	Xeon E5-4603 4C 2.0GHz 10MB 1066MHz 95W	No	Yes	-
90Y9062	A2C3 / A2C5	Xeon E5-4607 6C 2.2GHz 12MB 1066MHz 95W	Yes	No	B2x and B4x
69Y3100	A2C4	Xeon E5-4607 6C 2.2GHz 12MB 1066MHz 95W	No	Yes	-
90Y9064	A2C6 / A2C8	Xeon E5-4610 6C 2.4GHz 15MB 1333MHz 95W	Yes	No	C2x and C4x
69Y3106	A2C7	Xeon E5-4610 6C 2.4GHz 15MB 1333MHz 95W	No	Yes	-
90Y9066	A2C9 / A2CB	Xeon E5-4617 6C 2.9GHz 15MB 1600MHz 130W	Yes	No	-
90Y9049	A2CA	Xeon E5-4617 6C 2.9GHz 15MB 1600MHz 130W	No	Yes	-
90Y9070	A2CC / A2CH	Xeon E5-4620 8C 2.2GHz 16MB 1333MHz 95W	Yes	No	D2x and D4x
69Y3112	A2CG	Xeon E5-4620 8C 2.2GHz 16MB 1333MHz 95W	No	Yes	-
90Y9068	A2CF / A2CE	Xeon E5-4640 8C 2.4GHz 20MB 1600MHz 95W	Yes	No	-
90Y9055	A2CD	Xeon E5-4640 8C 2.4GHz 20MB 1600MHz 95W	No	Yes	-
90Y9072	A2CJ / A2CL	Xeon E5-4650 8C 2.7GHz 20MB 1600MHz 130W	Yes	No	F2x and F4x
69Y3118	A2CK	Xeon E5-4650 8C 2.7GHz 20MB 1600MHz 130W	No	Yes	-
90Y9186	A2QU / A2QW	Xeon E5-4650L 8C 2.6GHz 20MB 1600MHz 115W	Yes	No	-
90Y9185	A2QV	Xeon E5-4650L 8C 2.6GHz 20MB 1600MHz 115W	No	Yes	-

* When two feature codes are specified, the first feature code is for CPU 1 and the second feature code is for CPU 2

Memory options

IBM DDR3 memory is compatibility tested and tuned for optimal performance and throughput. IBM memory specifications are integrated into the light path diagnostic tests for immediate system performance feedback and optimum system uptime. From a service and support standpoint, IBM memory automatically assumes the IBM system warranty, and IBM provides service and support worldwide.

The x440 supports DDR3 memory. The compute node supports up to 48 DIMMs when four processors are installed, with 12 DIMMs for each processor. Each processor has four memory channels, and there are three DIMMs per channel.

The following rules apply when selecting the memory configuration:

- The server supports UDIMMs, RDIMMs and LRDIMMs.
- Mixing different types of memory (eg RDIMMs and LRDIMMs) is not supported.
- Mixing 1.5 V and 1.35 V DIMMs in the same server is supported; in such a case, all DIMMs operate at 1.5 V.
- The maximum number of ranks per one channel is eight (with the exception of Load Reduced DIMMs, where more than eight ranks are supported, because one quad-rank LRDIMM provides the same electrical load on a memory bus as a single-rank RDIMM).
- The maximum quantity of DIMMs that can be installed in the server depends on the number of processors installed. The following table shows the maximum when all four processors are installed. When two processors are installed, the maximum quantity supported is a half of the quantity that is shown.
- All DIMMs in the server operate at the same speed, which is determined as the lowest value of:
    - The memory speed that is supported by the specific processor.
    - The lowest of maximum operating speeds for the selected memory configuration that depends on rated speed, operating voltage, and quantity of DIMMs per channel, as shown under "Max. operating speed" section in the table.

The following table shows the maximum memory speeds that are achievable based on the installed DIMMs and the number of DIMMs per channel. The table also shows the maximum memory capacity at any speed supported by the DIMM and the maximum memory capacity at the rated DIMM speed.

In the table:

- The entries highlighted in red text indicate that the x440 supports higher memory frequencies than the Intel processor specification. In some instances, this configuration also results larger memory capacity that the specification recommends.
- Cells highlighted with a grey background indicate when the specific combination of DIMM voltage and number of DIMMs per channel still allows the DIMMs to operate at the rated speed.

Table 4. Maximum memory speeds

DIMM specification	**UDIMMs**	**RDIMMs**				**LRDIMMs**
Ranks	Dual-rank DIMMs	Single-rank DIMMs		Dual-rank DIMMs		Quad-rank LRDIMMs
Part numbers	49Y1404 (4 GB)	49Y1406 (4 GB)	49Y1559 (4 GB)	49Y1407 (4 GB) 49Y1397 (8 GB) 49Y1563 (16 GB)	90Y3109 (8 GB) 00D4968 (16 GB)	49Y1567 (16 GB) 90Y3105 (32 GB)
Rated speed	1333 MHz	1333 MHz	1600 MHz	1333 MHz	1600 MHz	1333 MHz
Rated voltage	1.35 V	1.35 V	1.5 V	1.35 V	1.5 V	1.35 V
Max. qty supported*	32	48	48	48	48	48
Max. DIMM capacity	4 GB	4 GB	4 GB	16 GB	16 GB	32 GB
Max. mem. capacity	128 GB	192 GB	192 GB	768 GB	768 GB	1.5 TB
Max memory at rated speed	128 GB	128 GB	128 GB	512 GB	512 GB	1 TB
Max operating speed (MHz) and operating voltage (operates at rated voltage unless specified)						
1 DIMM per channel	1333 MHz	1333 MHz	1600 MHz	1333 MHz	1600 MHz	1333 MHz
2 DIMMs per channel	1333 MHz	1333 MHz	1600 MHz	1333 MHz	1600 MHz	1333 MHz
3 DIMMs per channel	No support	1066 MHz	1066 MHz	1066 MHz	1066 MHz	1066 MHz

* The maximum quantity supported is shown for four processors installed. When two processors are installed, the maximum quantity supported is a half of the quantity that is shown. When one processor is installed, the quantity is one quarter of that shown.

The following memory protection technologies are supported:

- ECC
- Chipkill (for x4-based memory DIMMs only; look for "x4" in the DIMM description)
- Memory mirroring
- Memory rank sparing

If memory mirroring is used, then DIMMs must be installed in pairs (minimum of one pair per processor), and both DIMMs in a pair must be identical in type and size.

If memory rank sparing is used, then a minimum of one quad-rank DIMM or two single-rank or dual-rank DIMMs must be installed per populated channel (the DIMMs do not need being identical). In rank sparing mode, one rank of a DIMM in each populated channel is reserved as spare memory. The size of a rank varies depending on the DIMMs installed.

The following table lists the memory options that are available for the x440 Compute Node.

Table 5. Memory options

Part number	Feature code	Description	Maximum supported	Where used
UDIMMs				
49Y1404	8648	4GB (1x4GB, 2Rx8, 1.35V) PC3L-10600 CL9 ECC DDR3 1333MHz LP UDIMM	32 (8 per processor)	-
RDIMMs - 1333 MHz				
49Y1406	8941	4GB (1x4GB, 1Rx4, 1.35V) PC3L-10600 CL9 ECC DDR3 1333MHz LP RDIMM	48 (12 per processor)	-
49Y1407	8942	4GB (1x4GB, 2Rx8, 1.35V) PC3L-10600 CL9 ECC DDR3 1333MHz LP RDIMM	48 (12 per processor)	-
49Y1397	8923	8GB (1x8GB, 2Rx4, 1.35V) PC3L-10600 CL9 ECC DDR3 1333MHz LP RDIMM	48 (12 per processor)	All other models
49Y1563	A1QT	16GB (1x16GB, 2Rx4, 1.35V) PC3L-10600 CL9 ECC DDR3 1333MHz LP RDIMM	48 (12 per processor)	-
RDIMMs - 1600 MHz				
49Y1559	A28Z	4GB (1x4GB, 1Rx4, 1.5V) PC3-12800 CL11 ECC DDR3 1600MHz LP RDIMM	48 (12 per processor)	-
90Y3109	A292	8GB (1x8GB, 2Rx4, 1.5V) PC3-12800 CL11 ECC DDR3 1600MHz LP RDIMM	48 (12 per processor)	F2x and F4x
00D4968	A2U5	16GB (1x16GB, 2Rx4, 1.5V) PC3-12800 CL11 ECC DDR3 1600MHz LP RDIMM	48 (12 per processor)	-
LRDIMMs				
49Y1567	A290	16GB (1x16GB, 4Rx4, 1.35V) PC3L-10600 CL9 ECC DDR3 1333MHz LP LRDIMM	48 (12 per processor)	-
90Y3105	A291	32GB (1x32GB, 4Rx4, 1.35V) PC3L-10600 CL9 ECC DDR3 1333MHz LP LRDIMM	48 (12 per processor)	-

Internal disk storage options

The x440 server has two 2.5-inch hot-swap drive bays accessible from the front of the blade server (Figure 2). These bays are connected to the integrated 4-port LSI SAS2004 6 Gbps SAS/SATA RAID-on-Chip (ROC) controller.

The integrated LSI SAS2004 ROC has the following features:

- Four-port controller with 6 Gbps throughput per port
- PCIe x4 Gen 2 host interface
- Two SAS ports routed internally to the two hot-swap drive bays
- Supports RAID levels 0 (Integrated Striping), 1 (Integrated Mirroring), 10 (Integrated Mirroring and Striping), and 1E (Integrated Mirroring Enhanced)

The 2.5-inch drive bays support SAS or SATA HDDs or SATA SSDs. The following table lists the supported 2.5-inch drive options.

Table 6. 2.5-inch drive options for internal disk storage

Part number	Feature code	Description	Maximum supported
10K SAS hard disk drives			
81Y9650	A282	IBM 900GB 10K 6Gbps SAS 2.5" SFF HS HDD	2
90Y8872	A2XD	IBM 600GB 10K 6Gbps SAS 2.5" SFF G2HS HDD	2
90Y8877	A2XC	IBM 300GB 10K 6Gbps SAS 2.5" SFF G2HS HDD	2
10K and 15K SAS self-encrypting drives (SEDs)*			
81Y9662	A3EG	IBM 900GB 10K 6Gbps SAS 2.5" SFF G2HS SED	2
90Y8908	A3EF	IBM 600GB 10K 6Gbps SAS 2.5" SFF G2HS SED	2
90Y8913	A2XF	IBM 300GB 10K 6Gbps SAS 2.5" SFF G2HS SED	2
44W2264	5413	IBM 300GB 10K 6Gbps SAS 2.5" SFF Slim-HS SED	2
90Y8944	A2ZK	IBM 146GB 15K 6Gbps SAS 2.5" SFF G2HS SED	2
15K SAS hard disk drives			
81Y9670	A283	IBM 300GB 15K 6Gbps SAS 2.5" SFF HS HDD	2
90Y8926	A2XB	IBM 146GB 15K 6Gbps SAS 2.5" SFF G2HS HDD	2
NL SATA			
81Y9730	A1AV	IBM 1TB 7.2K 6Gbps NL SATA 2.5" SFF HS HDD	2
81Y9726	A1NZ	IBM 500GB 7.2K 6Gbps NL SATA 2.5" SFF HS HDD	2
81Y9722	A1NX	IBM 250GB 7.2K 6Gbps NL SATA 2.5" SFF HS HDD	2
NL SAS			
81Y9690	A1P3	IBM 1TB 7.2K 6Gbps NL SAS 2.5" SFF HS HDD	2
90Y8953	A2XE	IBM 500GB 7.2K 6Gbps NL SAS 2.5" SFF G2HS HDD	2
SSD			
49Y6129	A3EW	IBM 200GB SAS 2.5" MLC HS Enterprise SSD	2
49Y6134	A3EY	IBM 400GB SAS 2.5" MLC HS Enterprise SSD	2
49Y6139	A3F0	IBM 800GB SAS 2.5" MLC HS Enterprise SSD	2
00W1125	A3HR	IBM 100GB SATA 2.5" MLC HS Enterprise SSD	2
43W7718	A2FN	IBM 200GB SATA 2.5" MLC HS SSD	2
90Y8643	A2U3	IBM 256GB SATA 2.5" MLC HS Enterprise Value SSD	2
90Y8648	A2U4	IBM 128GB SATA 2.5" MLC HS Enterprise Value SSD	2

* Supports self-encrypting drive (SED) technology. For more information, see *Self-Encrypting Drives for IBM System x* at http://www.redbooks.ibm.com/abstracts/tips0761.html?Open.

Support for 1.8-inch SSDs

In addition, the x440 supports up to eight 1.8-inch SSDs combined with a ServeRAID M5115 SAS/SATA controller (90Y4390). The M5115 attaches to the I/O adapter 1 connector and can be attached even if the Compute Node Fabric Connector is installed (used to route the Embedded 10Gb Virtual Fabric Adapter to bays 1 and 2, as described in "I/O expansion options"). The ServeRAID M5115 cannot be installed if an adapter is installed in I/O adapter slot 1.

The ServeRAID M5115 supports combinations of 2.5-inch drives and 1.8-inch SSDs:

- Up to two 2.5-inch drives only
- Up to four 1.8-inch drives only
- Up to two 2.5-inch drives, plus up to four 1.8-inch SSDs
- Up to eight 1.8-inch SSDs

The ServeRAID M5115 SAS/SATA Controller (90Y4390) provides an advanced RAID controller supporting RAID 0, 1, 10, 5, 50, and, optionally, 6 and 60. It includes 1 GB of cache, which can be backed up to flash memory when attached to the supercapacitor included with the optional ServeRAID M5100 Series Enablement Kit (46C9030).

At least one hardware kit is required with the ServeRAID M5115 controller, and there are three hardware kits that are supported that enable specific drive support, as listed in the following table.

Table 7. Supported upgrade features

Part number	Feature code	Description	Maximum supported
90Y4390	A2XW	ServeRAID M5115 SAS/SATA Controller	1*
46C9030	A3DS	ServeRAID M5100 Series Enablement Kit for IBM Flex System x440	1
46C9031	A3DT	ServeRAID M5100 Series IBM Flex System Flash Kit for x440	1
46C9032	A3DU	ServeRAID M5100 Series SSD Expansion Kit for IBM Flex System x440	1

* Ensure the IMM2 firmware of the x440 is at least level 40A for full compatibility

The ServeRAID M5115 hardware kits are as follows:

- **ServeRAID M5100 Series Enablement Kit for IBM Flex System x440** (46C9030) enables support for up to two 2.5-inch HDDs or SSDs in the hot-swap bays in the front of the server. It includes a CacheVault unit, which enables MegaRAID CacheVault flash cache protection. This enablement kit replaces the two standard 1-bay backplanes (which are attached through the planar to an onboard controller) with new 1-bay backplanes that attach to an included flex cable to the M5115 controller. It also includes an air baffle, which also serves as an attachment for the CacheVault unit.

  MegaRAID CacheVault flash cache protection uses NAND flash memory powered by a supercapacitor to protect data stored in the controller cache. This module eliminates the need for a lithium-ion battery commonly used to protect DRAM cache memory on PCI RAID controllers. To avoid the possibility of data loss or corruption during a power or server failure, CacheVault technology transfers the contents of the DRAM cache to NAND flash memory using power from the supercapacitor. After the power is restored to the RAID controller, the saved data is transferred from the NAND flash memory back to the DRAM cache, which can then be flushed to disk.

  Tip: The Enablement Kit is only required if 2.5-inch drives are to be used. If you plan to install four or eight 1.8-inch SSDs only, then this kit is not required.
- **ServeRAID M5100 Series IBM Flex System Flash Kit for x440** (46C9031) enables support for up to four 1.8-inch SSDs. This kit replaces the two standard 1-bay backplanes with a two 2-bay backplanes that attach to an included flex cable to the M5115 controller. Because only SSDs are supported, a CacheVault unit is not required, and therefore this kit does not have a supercapacitor.
- **ServeRAID M5100 Series SSD Expansion Kit for IBM Flex System x440** (46C9032) enables support for up to four internal 1.8-inch SSDs. This kit includes two air baffles which can attach two 1.8-inch SSD attachment locations and flex cables for attachment to up to four 1.8-inch SSDs.

Note: The above kits are specific for the x440 and cannot be used with the x240 or x220.

The following table shows the kits required for each combination of drives. For example, if you plan to install eight 1.8-inch SSDs, then you need the M5115 controller, the Flash Kit, and the SSD Expansion kit.

Table 8. ServeRAID M5115 hardware kits

Desired drive support			Components required			
Maximum number of 2.5-inch drives	Maximum number of 1.8-inch SSDs		ServeRAID M5115 90Y4390	Enablement Kit 46C9030	Flash Kit 46C9031	SSD Expansion Kit 46C9032
2	0	=>	Required	Required		
0	4 (front)	=>	Required		Required	
2	4 (internal)	=>	Required	Required		Required
0	8 (both)	=>	Required		Required	Required

Figure 4 shows how the ServeRAID M5115 and the Enablement Kit are installed in the server to support two 2.5-inch drives with MegaRAID CacheVault flash cache protection (row 1 of previous table).

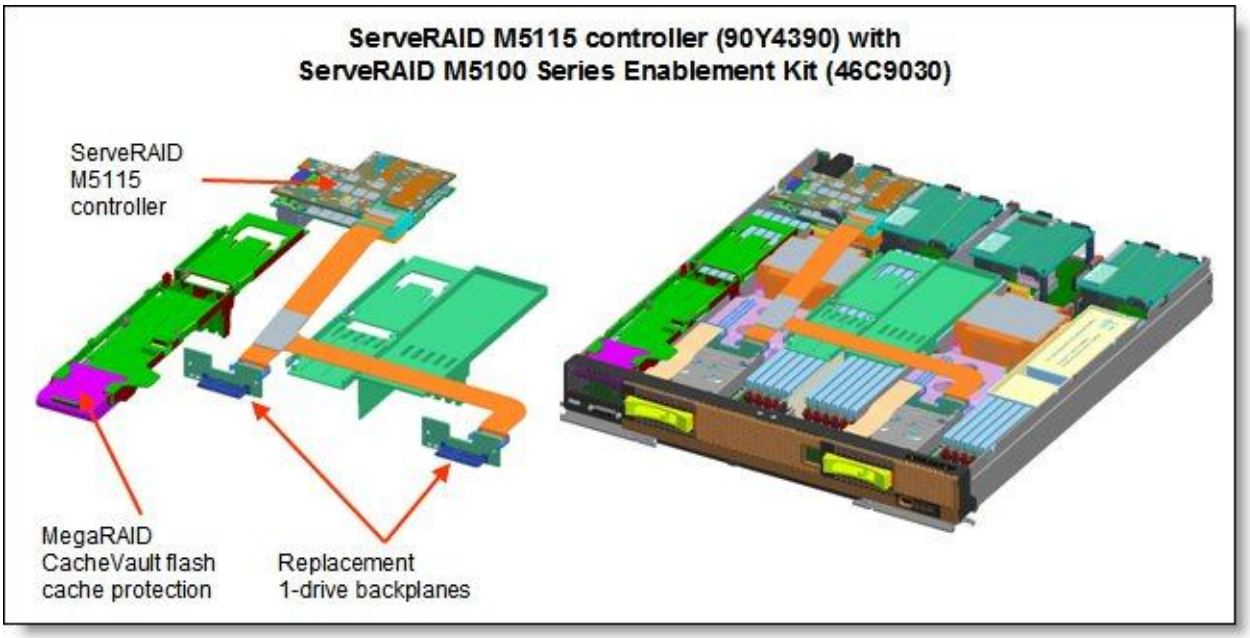

Figure 4. The ServeRAID M5115 and the Enablement Kit installed

Figure 5 shows how the ServeRAID M5115 and Flash and SSD Expansion Kits are installed in the server to support eight 1.8-inch solid-state drives (row 4 of the previous table).

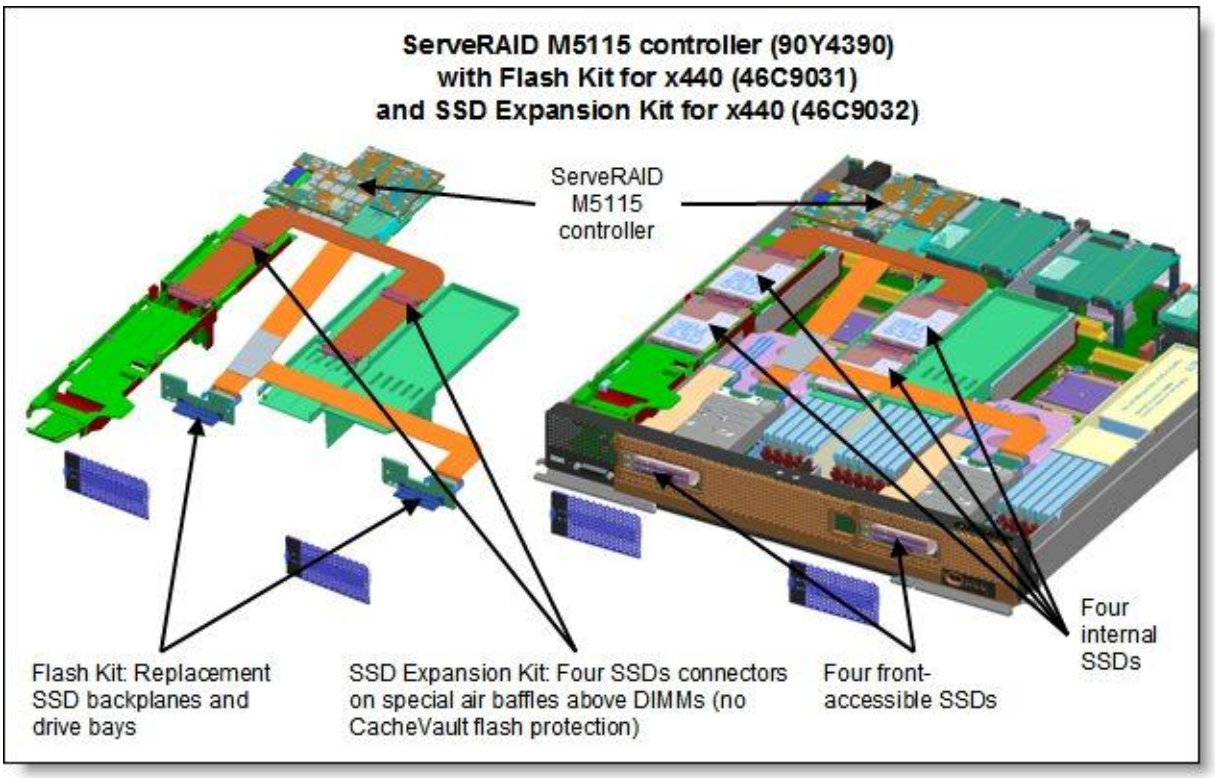

Figure 5. ServeRAID M5115 with Flash and SSD Expansion Kits installed

The eight SSDs are installed in the following locations:

- Four in the front of the system in place of the two 2.5-inch drive bays
- Four on trays above the memory banks

The ServeRAID M5115 controller has the following specifications:

- Eight internal 6 Gbps SAS/SATA ports
- PCI Express 3.0 x8 host interface
- 6 Gbps throughput per port
- 800 MHz dual-core IBM PowerPC® processor with LSI SAS2208 6 Gbps RAID on Chip (ROC) controller
- Support for RAID levels 0, 1, 10, 5, 50 standard; support for RAID 6 and 60 with optional upgrade using 90Y4411
- Optional onboard 1 GB data cache (DDR3 running at 1333 MHz) with optional flash backup (MegaRAID CacheVault technology) as part of the Enablement Kit 90Y4342.
- Support for SAS and SATA HDDs and SSDs
- Support for intermixing SAS and SATA HDDs and SSDs; mixing different types of drives in the same array (drive group) is not recommended
- Support for self-encrypting drives (SEDs) with MegaRAID SafeStore
- Optional support for SSD performance acceleration with MegaRAID FastPath and SSD caching with MegaRAID CacheCade Pro 2.0 (90Y4447)
- Support for up to 64 virtual drives, up to 128 drive groups, up to 16 virtual drives per one drive group, and up to 32 physical drives per one drive group
- Support for logical unit number (LUN) sizes up to 64 TB
- Configurable stripe size up to 1 MB
- Compliant with Disk Data Format (DDF) configuration on disk (COD)
- S.M.A.R.T. support
- MegaRAID Storage Manager management software

Optional add-ons to the ServeRAID M5115 controller are RAID 6 support, SSD performance upgrade, and SSD caching enabler. The feature upgrades are as listed in the following table. These are all Feature on Demand (FoD) license upgrades.

Table 9. Supported upgrade features

Part number	Feature code	Description	Maximum supported
90Y4410	A2Y1	ServeRAID M5100 Series RAID 6 Upgrade for IBM Flex System	1
90Y4412	A2Y2	ServeRAID M5100 Series Performance Upgrade for IBM Flex System (MegaRAID FastPath)	1
90Y4447	A36G	ServeRAID M5100 Series SSD Caching Enabler for IBM Flex System (MegaRAID CacheCade Pro 2.0)	1

These features are described as follows:

- RAID 6 Upgrade (90Y4410)

  Adds support for RAID 6 and RAID 60. This is a Feature on Demand license.

- Performance Upgrade (90Y4412)

  The Performance Upgrade for IBM Flex System (implemented using the LSI MegaRAID FastPath software) provides high-performance I/O acceleration for SSD-based virtual drives by using a low-latency I/O path to increase the maximum I/O per second (IOPS) capability of the controller. This feature boosts the performance of applications with a highly random data storage access pattern, such as transactional databases. Part number 90Y4412 is a Feature on Demand license.

- SSD Caching Enabler for traditional hard drives (90Y4447)

  The SSD Caching Enabler for IBM Flex System (implemented using the LSI MegaRAID CacheCade Pro 2.0) is designed to accelerate the performance of HDD arrays with only an incremental investment in SSD technology. The feature enables the SSDs to be configured as a dedicated cache to help maximize the I/O performance for transaction-intensive applications, such as databases and web serving. The feature tracks data storage access patterns and identifies the most frequently accessed data. The hot data is then automatically stored on the SSDs that are assigned as a dedicated cache pool on the ServeRAID controller. Part number 90Y4447 is a Feature on Demand license. This feature requires at least one SSD drive be installed.

The 1.8-inch SSDs supported with the ServeRAID M5115 controller are listed in the following table.

Table 10. Supported 1.8-inch SSDs

Part number	Feature code	Description	Maximum supported
43W7746	5420	IBM 200GB SATA 1.8" MLC SSD	8
43W7726	5428	IBM 50GB SATA 1.8" MLC SSD	8

Internal tape drives

The server does not support an internal tape drive. However, it can be attached to external tape drives using Fibre Channel connectivity.

Optical drives

The server does not support an internal optical drive option. However, you can connect an external USB optical drive, such as the IBM and Lenovo part number 73P4515 or 73P4516, or use the remote media feature of the IMMv2 and the Chassis Management Module.

Note: The USB port on the compute node supplies up to 0.5 A at 5 V. For devices that require more power, an additional power source will be required.

Embedded 10Gb Virtual Fabric

Some models of the x440 include two Embedded 10Gb Virtual Fabric controllers (VFA, also known as LAN on Motherboard (LOM)) built into the system board. Table 2 lists what models of the x440 include the Embedded 10Gb Virtual Fabric controllers. Each x440 model that includes the embedded 10 Gb also has the Compute Node Fabric Connector installed in each of I/O connectors 1 and 3 (and physically screwed onto the system board) to provide connectivity to the Enterprise Chassis midplane.

The Fabric Connector enables port 1 of each embedded 10 Gb controller to be routed to I/O module bay 1 and port 2 of each controller to be routed to I/O module bay 2. The Fabric Connectors can be unscrewed and removed, if required, to allow the installation of an I/O adapter on I/O connector 1 and 3.

The Embedded 10Gb controllers are based on the Emulex BladeEngine 3 (BE3), which is a single-chip, dual-port 10 Gigabit Ethernet (10GbE) Ethernet Controller. Here are some of the features of the Embedded 10Gb controller:

- PCI-Express Gen2 x8 host bus interface
- Supports connection to 10 Gb and 1 Gb Flex System Ethernet switches
- Supports multiple virtual NIC (vNIC) functions
- TCP/IP Offload Engine (TOE enabled)
- SRIOV capable
- RDMA over TCP/IP capable
- iSCSI and FCoE upgrade offering via FoD

The following table lists the ordering information for the IBM Flex System Embedded 10Gb Virtual Fabric Upgrade, which enables the iSCSI and FCoE support on the Embedded 10Gb Virtual Fabric controller. To upgrade both controllers, you need two FoD licenses.

Table 11. Feature on Demand upgrade for FCoE and iSCSI support

Part number	Feature code	Description	Maximum supported
90Y9310	A2TD	IBM Flex System Embedded 10Gb Virtual Fabric Upgrade	2

I/O expansion options

The x440 has four I/O expansion connectors for attaching I/O adapter cards, as shown in Figure 6. There is a fifth expansion connector (under I/O adapter 4) designed for future expansion options. The I/O expansion connector is a very high-density 216-pin PCIe connector. Installing I/O adapter cards allows the server to connect with switch modules in the IBM Flex System Enterprise Chassis. Each slot has a PCI Express 3.0 x16 host interface and all slots support the same form-factor adapters.

Note: A second processor must be installed in order to use I/O adapter slots 3 and 4 in the x440 compute node. This is because the PCIe lanes used to drive I/O slots 3 and 4 are routed to processors 2 and 4.

Figure 6 shows the location of the I/O expansion connectors.

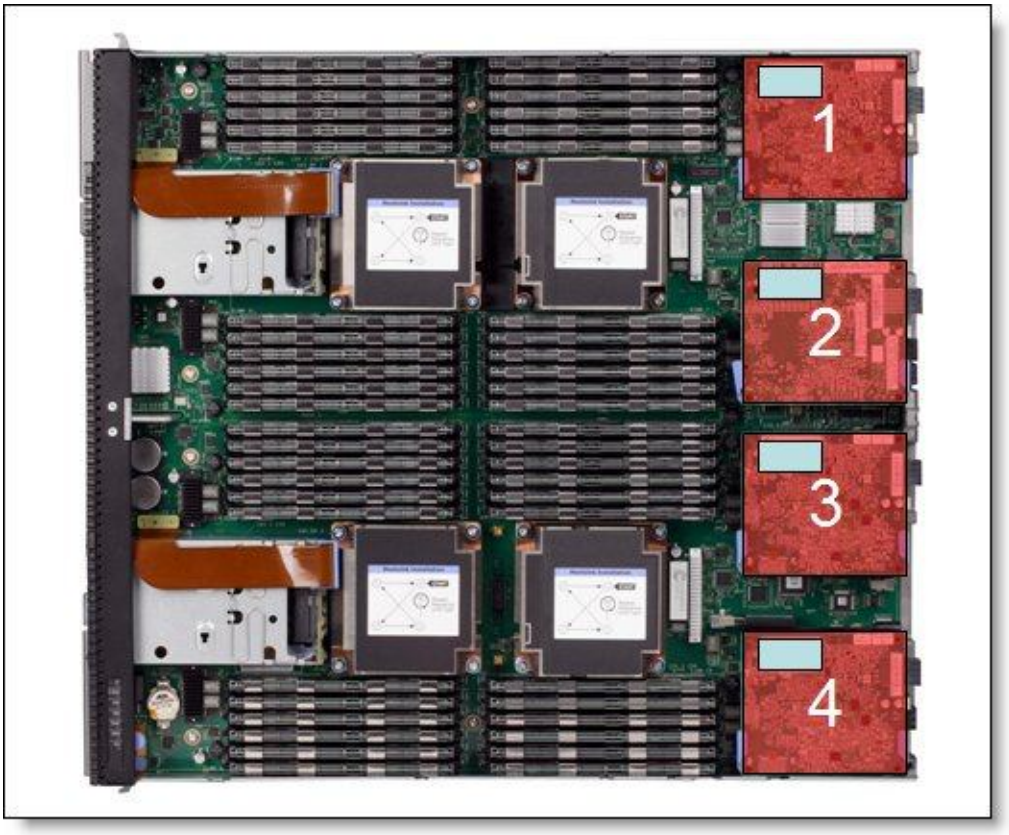

Figure 6. Location of the I/O adapter slots in the IBM Flex System x440 Compute Node

All I/O adapters are the same shape and can be used in any available slot. A compatible switch or pass-through module must be installed in the corresponding I/O bays in the chassis, as indicated in the following table. Installing two switches means that all ports of the adapter are enabled, which improves performance and network availability.

Table 12. Adapter to I/O bay correspondence

I/O adapter slot in the server	Port on the adapter	Corresponding I/O module bay in the chassis
Slot 1	Port 1	Module bay 1
	Port 2	Module bay 2
	Port 3 (for 4-port cards)	Module bay 1
	Port 4 (for 4-port cards)	Module bay 2
Slot 2	Port 1	Module bay 3
	Port 2	Module bay 4
	Port 3 (for 4-port cards)	Module bay 3
	Port 4 (for 4-port cards)	Module bay 4
Slot 3	Port 1	Module bay 1
	Port 2	Module bay 2
	Port 3 (for 4-port cards)	Module bay 1
	Port 4 (for 4-port cards)	Module bay 2
Slot 4	Port 1	Module bay 3
	Port 2	Module bay 4
	Port 3 (for 4-port cards)	Module bay 3
	Port 4 (for 4-port cards)	Module bay 4

For a list of supported switches, see the IBM Flex System Interoperability Guide, available from: http://www.redbooks.ibm.com/fsig

Figure 7 shows the location of the switch bays in the IBM Flex System Enterprise Chassis.

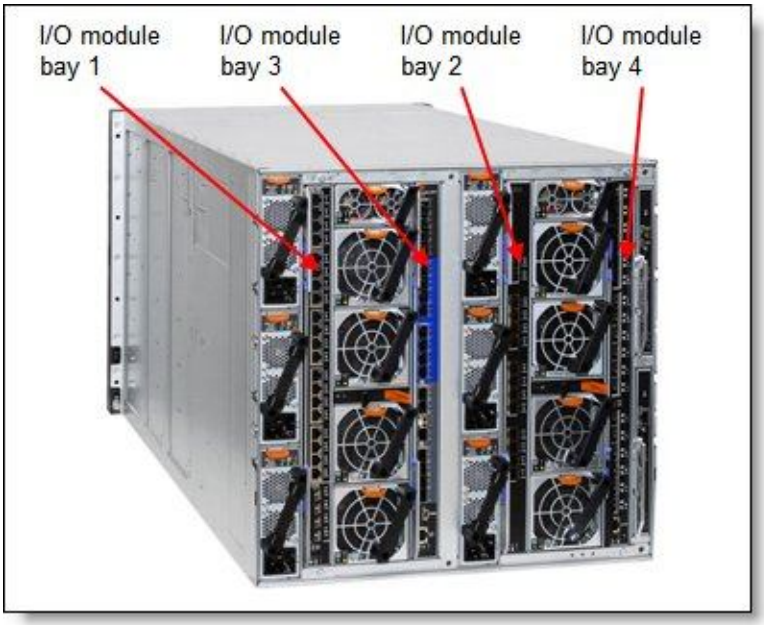

Figure 7. Location of the switch bays in the IBM Flex System Enterprise Chassis

Figure 8 shows how 2-port adapters are connected to switches installed in the chassis.

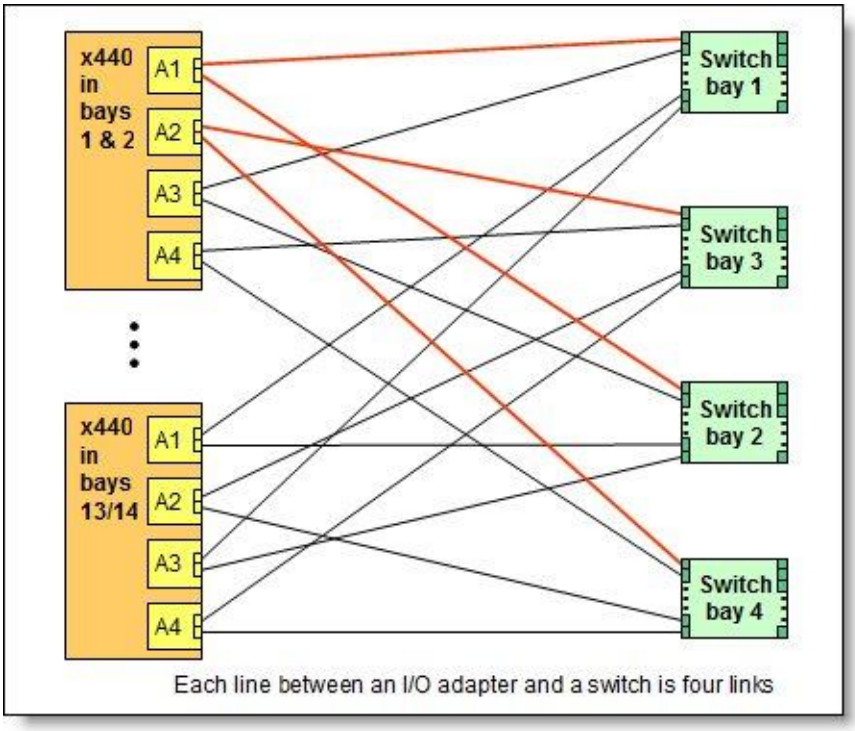

Figure 8. Logical layout of the interconnects between I/O adapters and I/O modules

Network adapters

As described in "Embedded 10Gb Virtual Fabric," certain models (those with a model number of the form x4x) have two 10 Gb Ethernet controllers on the system board, and its ports are routed to the midplane and switches installed in the chassis through two Compute Note Fabric Connectors that takes the place of adapters in I/O slots 1 and 3.

Models without the Embedded 10Gb Virtual Fabric controller (those with a model number of the form x2x) do not include any other Ethernet connections to the Enterprise Chassis midplane as standard. Therefore, for those models, an I/O adapter must be installed to provide network connectivity between the server and the chassis midplane and ultimately to the network switches.

The following table lists the supported network adapters and upgrades. Adapters can be installed in any slot. However, compatible switches must be installed in the corresponding bays of the chassis.

Table 13. Network adapters

Part number	Feature code	Description	Number of ports	Maximum supported*
10 Gb Ethernet				
90Y3554	A1R1	IBM Flex System CN4054 10Gb Virtual Fabric Adapter	4	4
90Y3558	A1R0	IBM Flex System CN4054 Virtual Fabric Adapter (SW Upgrade) (Feature on Demand to provide FCoE and iSCSI support)	License	4
90Y3466	A1QY	IBM Flex System EN4132 2-port 10Gb Ethernet Adapter	2	4
1 Gb Ethernet				
49Y7900	A10Y	IBM Flex System EN2024 4-port 1Gb Ethernet Adapter	4	4
InfiniBand				
90Y3454	A1QZ	IBM Flex System IB6132 2-port FDR InfiniBand Adapter	2	2

* For x4x models with two Embedded 10Gb Virtual Fabric controllers standard, the Compute Node Fabric Connectors occupy the same space as the I/O adapters in I/O slots 1 and 3, so you have to remove the Fabric Connectors if you plan to install adapters in those I/O slots. To use slots 3 and 4 requires the second processor.

Storage host bus adapters

The following table lists storage HBAs supported by the x440 server.

Table 14. Storage adapters

Part number	Feature code	Description	Number of ports	Maximum supported*
Fibre Channel				
88Y6370	A1BP	IBM Flex System FC5022 2-port 16Gb FC Adapter	2	2
69Y1938	A1BM	IBM Flex System FC3172 2-port 8Gb FC Adapter	2	2
95Y2375	A2N5	IBM Flex System FC3052 2-port 8Gb FC Adapter	2	2

* For x4x models with two Embedded 10Gb Virtual Fabric controllers standard, the Compute Node Fabric Connectors occupy the same space as the I/O adapters in I/O slots 1 and 3, so you have to remove the Fabric Connectors if you plan to install adapters in those I/O slots. To use slots 3 and 4 requires the second processor.

Power supplies

Server power is derived from the power supplies installed in the chassis. There are no server options regarding power supplies.

Integrated virtualization

The x440 supports the ESXi hypervisor on a USB memory key via two internal USB ports (see Figure 3). The supported USB memory keys are listed in the following table.

There are two types of USB keys, preloaded keys or blank keys. Blank keys allow you to download an IBM customized version of ESXi and load it onto the key. The x440 supports one or two keys installed, but only certain combinations:

Supported combinations:
- One preload key
- One blank key
- One preload key and one blank key
- Two blank keys

Unsupported combinations:
- Two preload keys

Installing two preloaded keys will prevent ESXi from booting as described in http://kb.vmware.com/kb/1035107. Having two keys installed provides a backup boot device. both devices are listed in the boot menu, which allows you to boot from either device or to set one as a backup in case the first one gets corrupted.

The supported USB memory keys are listed in the following table.

Table 15. Virtualization options

Part number	Feature code	Description	Maximum supported
41Y8298	A2G0	IBM Blank USB Memory Key for VMware ESXi Downloads	2
41Y8300	A2VC	IBM USB Memory Key for VMware ESXi 5.0	2
41Y8307	A383	IBM USB Memory Key for VMware ESXi 5.0 Update 1	2
41Y8311	A2R3	IBM USB Memory Key for VMware ESXi 5.1	2

Light path diagnostics panel

For quick problem determination when located physically at the server, the x440 offers a 3-step guided path:

1. The Fault LED on the front panel
2. The light path diagnostics panel
3. LEDs next to key components on the system board

The x440 light path diagnostics panel is visible when you remove the server from the chassis. The panel is located at the upper right side of the compute node, as shown in Figure 9.

Figure 9. Location of x440 light path diagnostics panel

To illuminate the light path diagnostics LEDs, power off the compute node, slide it out of the chassis, and press the power button. The power button doubles as the light path diagnostics remind button when the server is removed from the chassis. The meanings of the LEDs are listed in the following table.

Table 16. Light path diagnostic panel LEDs

LED	Meaning
LP	The light path diagnostics panel is operational.
S BRD	A system board error is detected.
MIS	A mismatch has occurred between the processors, DIMMs, or HDDs.
NMI	A non-maskable interrupt (NMI) has occurred.
TEMP	An over-temperature condition occurred that was critical enough to shut down the server.
MEM	A memory fault has occurred. The corresponding DIMM error LEDs on the system board are also lit.
ADJ	A fault is detected in the adjacent expansion unit (if installed).

Remote management

The server contains an IBM Integrated Management Module II (IMM2), which interfaces with the advanced management module in the chassis. The combination of these two components provides advanced service-processor control, monitoring, and an alerting function. If an environmental condition exceeds a threshold or if a system component fails, LEDs on the system board are lit to help you diagnose the problem, the error is recorded in the event log, and you are alerted to the problem. A virtual presence capability comes standard for remote server management.

Remote server management is provided through industry-standard interfaces:

- Intelligent Platform Management Interface (IPMI) Version 2.0
- Simple Network Management Protocol (SNMP) Version 3
- Common Information Model (CIM)
- Web browser

The server also supports virtual media and remote control features, which provide the following functions:

- Remotely viewing video with graphics resolutions up to 1600x1200 at 75 Hz with up to 23 bits per pixel, regardless of the system state
- Remotely accessing the server using the keyboard and mouse from a remote client
- Mapping the CD or DVD drive, diskette drive, and USB flash drive on a remote client, and mapping ISO and diskette image files as virtual drives that are available for use by the server
- Uploading a diskette image to the IMM2 memory and mapping it to the server as a virtual drive
- Capturing blue-screen errors

Supported operating systems

The server supports the following operating systems:

- Microsoft Windows Server 2008 R2
- Microsoft Windows Server 2008, Datacenter x64 Edition
- Microsoft Windows Server 2008, Enterprise x64 Edition
- Microsoft Windows Server 2008, Standard x64 Edition
- Microsoft Windows Server 2008, Web x64 Edition
- Microsoft Windows Server 2012
- Red Hat Enterprise Linux 5 Server with Xen x64 Edition
- Red Hat Enterprise Linux 5 Server x64 Edition
- Red Hat Enterprise Linux 6 Server x64 Edition
- SUSE LINUX Enterprise Server 10 for AMD64/EM64T
- SUSE LINUX Enterprise Server 11 for AMD64/EM64T
- SUSE LINUX Enterprise Server 11 with Xen for AMD64/EM64T
- VMware ESX 4.1
- VMware ESXi 4.1
- VMware vSphere 5.0 (ESXi)
- VMware vSphere 5.1 (ESXi)

Note: Support by some of these operating system versions will be after the date of initial availability. Check the IBM ServerProven® website for the latest information about the specific versions and service levels supported and any other prerequisites at the following website:
http://www.ibm.com/systems/info/x86servers/serverproven/compat/us/nos/matrix.shtml

Physical specifications

Dimensions and weight (approximate):

- Width: 437 mm (17.2 in.)
- Height 51 mm (2.0 in.)
- Depth 493 mm (19.4 in.)
- Maximum weight: 12.25 kg (27 lbs)

Shipping dimensions and weight (approximate):

- Height: 197 mm (7.8 in.)
- Depth: 603 mm (23.7 in.)
- Width: 430 mm (16.9 in.)
- Weight: 8 kg (17.6 lb)

Supported environment

The IBM Flex System x440 compute node complies with ASHRAE Class A3 specifications.

This is the supported operating environment:

Power on:

- Temperature: 5 - 40 °C (41 - 104 °F)
- Humidity, non-condensing: -12 °C dew point (10.4 °F) and 8 - 85% relative humidity
- Maximum dew point: 24 °C (75 °F)
- Maximum altitude: 3048 m (10,000 ft.)
- Maximum rate of temperature change: 5 °C/hr (41 °F/hr)

Power off:

- Temperature: 5 - 45 °C (41 - 113 °F)
- Relative humidity: 8 - 85%
- Maximum dew point: 27 °C (80.6 °F)

Storage (non-operating):

- Temperature: 1 - 60 °C (33.8 - 140 °F)
- Altitude: 3050 m (10,006 ft.)
- Relative humidity: 5 - 80%
- Maximum dew point: 29 °C (84.2°F)

Shipment (non-operating):

- Temperature: -40 - 60 °C (-40 - 140 °F)
- Altitude: 10,700 m (35,105 ft)
- Relative humidity: 5 - 100%
- Maximum dew point: 29 °C (84.2 °F)

Warranty options

The IBM Flex System x440 Compute Node has a 3-year on-site warranty with 9x5 next-business-day terms. IBM offers the warranty service upgrades through IBM ServicePac, discussed in this section. The IBM ServicePac is a series of prepackaged warranty maintenance upgrades and post-warranty maintenance agreements with a well-defined scope of services, including service hours, response time, term of service, and service agreement terms and conditions.

IBM ServicePac offerings are country-specific. Each country might have its own service types, service levels, response times, and terms and conditions. Not all covered types of ServicePac might be available in a particular country. For more information about IBM ServicePac offerings available in your country, see the IBM ServicePac Product Selector at https://www-304.ibm.com/sales/gss/download/spst/servicepac.

The following table explains warranty service definitions in more detail.

Table 17. Warranty service definitions

Term	Description
IBM on-site repair (IOR)	A service technician comes to the server's location for equipment repair.
24x7x2 hour	A service technician is scheduled to arrive at your customer's location within two hours after remote problem determination is completed. We provide 24-hour service, every day, including IBM holidays.
24x7x4 hour	A service technician is scheduled to arrive at your customer's location within four hours after remote problem determination is completed. We provide 24-hour service, every day, including IBM holidays.
9x5x4 hour	A service technician is scheduled to arrive at your customer's location within four business hours after remote problem determination is completed. We provide service from 8:00 a.m. to 5:00 p.m. in the customer's local time zone, Monday through Friday, excluding IBM holidays. If it is after 1:00 p.m. and it is determined that on-site service is required, the customer can expect the service technician to arrive the morning of the following business day. For noncritical service requests, a service technician arrives by the end of the following business day.
9x5 next business day	A service technician is scheduled to arrive at your customer's location on the business day after we receive your call after remote problem determination is completed. We provide service from 8:00 a.m. to 5:00 p.m. in the customer's local time zone, Monday through Friday, excluding IBM holidays.

In general, here are the types of IBM ServicePacs:

- Warranty and maintenance service upgrades
  - One, two, three, four, or five years of 9x5 or 24x7 service coverage
  - On-site repair from the next business day to four or two hours
  - One or two years of warranty extension
- Remote technical support services
  - One or three years with 24x7 coverage (severity 1) or 9-5 next business day for all severities
  - Installation and startup support for IBM System x® servers
  - Remote technical support for System x servers
  - Software support - Support Line
    - Microsoft or Linux software
    - VMware
    - IBM Systems Director

Regulatory compliance

The server conforms to the following standards:

- ASHRAE Class A3
- FCC - Verified to comply with Part 15 of the FCC Rules Class A
- Canada ICES-004, issue 3 Class A
- UL/IEC 60950-1
- CSA C22.2 No. 60950-1
- NOM-019
- Argentina IEC 60950-1
- Japan VCCI, Class A
- IEC 60950-1 (CB Certificate and CB Test Report)
- China CCC (GB4943); (GB9254, Class A); (GB17625.1)
- Taiwan BSMI CNS13438, Class A; CNS14336
- Australia/New Zealand AS/NZS CISPR 22, Class A
- Korea KN22, Class A, KN24
- Russia/GOST ME01, IEC 60950-1, GOST R 51318.22, GOST R
- 51318.249, GOST R 51317.3.2, GOST R 51317.3.3
- IEC 60950-1 (CB Certificate and CB Test Report)
- CE Mark (EN55022 Class A, EN60950-1, EN55024, EN61000-3-2,
- EN61000-3-3)
- CISPR 22, Class A
- TUV-GS (EN60950-1/IEC 60950-1, EK1-ITB2000)

IBM Global Financing

IBM Global Financing can help you obtain the IT solution you need while preserving funding for other strategic investments and optimizing cash flow. Our Fair Market Value (FMV) lease helps ensure that you have the latest IBM technology, and with our mid-lease upgrade capability, you can increase the capacity of the system with little to no change in monthly payments. At the end of the lease, take advantage of our flexible end-of-lease options to fit your changing business needs. IBM Global Financing has the breadth and depth of offerings, longevity, proven success. and global reach to help you develop a robust financing and asset management strategy that provides you with the opportunity to use new technologies and turn your ambitious vision into a tangible solution.

Here are some other reasons why working with us makes solid financial sense:

- Expand your purchasing power: Affordable monthly payments allow you to change the technology acquisition discussion from “what can I afford right now” to “what solution is really right for my business.” IBM Global Financing allows you to expand your purchase power to get you the right solution.
- Accelerate your project’s cash flow break-even point: Acquire your IBM technology today and begin to realize its benefits now. An FMV lease can help you get the solution you need now, with low monthly payments that better align upfront costs with the anticipated return on investment from the technology.
- Easy to acquire with affordable rates: We offer a one-stop shopping for a total IT solution, so you can acquire IBM hardware, software, services and the financing you need from one IT provider.

Plus, we provide simple, easy-to-understand contracts and quick approvals. As the world’s largest IT financing provider, with an asset base of US$35.8 billion and over 125,000 customers, IBM Global Financing offers highly competitive rates that promote low total cost of ownership (TCO) and low monthly payments.

IBM Global Financing operates in more than 50 countries. Go to http://ibm.com/financing for financing options in your country and to contact a local financing specialist.

IBM Global Financing offerings are provided through IBM Credit LLC in the United States and other IBM subsidiaries and divisions worldwide to qualified commercial and government clients. Rates and availability subject to client’s credit rating, financing terms, offering type, equipment and product type and options, and may vary by country. Non-hardware items must be one-time, non-recurring charges and are financed by means of loans. Other restrictions may apply. Rates and offerings are subject to change, extension or withdrawal without notice and may not be available in all countries. Please contact your local IBM Global Financing representative for additional detail.

Related publications and links

For more information, see the following resources:

- IBM US Product Announcement:
  http://ibm.com/common/ssi/cgi-bin/ssialias?infotype=dd&subtype=ca&&htmlfid=897/ENUS112-099
- IBM Flex System x440 Compute Node product page:
  http://ibm.com/systems/flex/compute-nodes/x86/bto/
- IBM Flex System Information Center:
  http://publib.boulder.ibm.com/infocenter/flexsys/information/index.jsp
- *IBM Flex System x440 Compute Node Installation and Service Guide*:
  http://publib.boulder.ibm.com/infocenter/flexsys/information/topic/com.ibm.acc.7917.doc/printable_doc.html
- ServerProven for IBM Flex System:
  http://ibm.com/systems/info/x86servers/serverproven/compat/us/flexsystems.html
- ServerProven compatibility page for operating system support:
  http://ibm.com/systems/info/x86servers/serverproven/compat/us/nos/flexmatrix.shtml
- IBM Redbooks® Product Guides for IBM Flex System servers and options:
  http://www.redbooks.ibm.com/Redbooks.nsf/portals/puresystems?Open&page=pgbycat
- *IBM Flex System Interoperability Guide*:
  http://www.redbooks.ibm.com/fsig
- *Configuration and Option Guide*:
  http://www.ibm.com/systems/xbc/cog/
- xREF - IBM System x Reference Sheets:
  http://www.redbooks.ibm.com/xref
- IBM System x Support Portal:
  http://ibm.com/support/entry/portal/
- IBM System Storage® Interoperation Center (SSIC):
  http://www.ibm.com/systems/support/storage/ssic

Notices

This information was developed for products and services offered in the U.S.A.

IBM may not offer the products, services, or features discussed in this document in other countries. Consult your local IBM representative for information on the products and services currently available in your area. Any reference to an IBM product, program, or service is not intended to state or imply that only that IBM product, program, or service may be used. Any functionally equivalent product, program, or service that does not infringe any IBM intellectual property right may be used instead. However, it is the user's responsibility to evaluate and verify the operation of any non-IBM product, program, or service. IBM may have patents or pending patent applications covering subject matter described in this document. The furnishing of this document does not give you any license to these patents. You can send license inquiries, in writing, to:

IBM Director of Licensing, IBM Corporation, North Castle Drive, Armonk, NY 10504-1785 U.S.A.

The following paragraph does not apply to the United Kingdom or any other country where such provisions are inconsistent with local law: INTERNATIONAL BUSINESS MACHINES CORPORATION PROVIDES THIS PUBLICATION "AS IS" WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF NON-INFRINGEMENT, MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. Some states do not allow disclaimer of express or implied warranties in certain transactions, therefore, this statement may not apply to you. This information could include technical inaccuracies or typographical errors. Changes are periodically made to the information herein; these changes will be incorporated in new editions of the publication. IBM may make improvements and/or changes in the product(s) and/or the program(s) described in this publication at any time without notice.

Any references in this information to non-IBM Web sites are provided for convenience only and do not in any manner serve as an endorsement of those Web sites. The materials at those Web sites are not part of the materials for this IBM product and use of those Web sites is at your own risk.IBM may use or distribute any of the information you supply in any way it believes appropriate without incurring any obligation to you. Information concerning non-IBM products was obtained from the suppliers of those products, their published announcements or other publicly available sources. IBM has not tested those products and cannot confirm the accuracy of performance, compatibility or any other claims related to non-IBM products. Questions on the capabilities of non-IBM products should be addressed to the suppliers of those products. This information contains examples of data and reports used in daily business operations. To illustrate them as completely as possible, the examples include the names of individuals, companies, brands, and products. All of these names are fictitious and any similarity to the names and addresses used by an actual business enterprise is entirely coincidental.

Any performance data contained herein was determined in a controlled environment. Therefore, the results obtained in other operating environments may vary significantly. Some measurements may have been made on development-level systems and there is no guarantee that these measurements will be the same on generally available systems. Furthermore, some measurement may have been estimated through extrapolation. Actual results may vary. Users of this document should verify the applicable data for their specific environment.

COPYRIGHT LICENSE:

This information contains sample application programs in source language, which illustrate programming techniques on various operating platforms. You may copy, modify, and distribute these sample programs in any form without payment to IBM, for the purposes of developing, using, marketing or distributing application programs conforming to the application programming interface for the operating platform for which the sample programs are written. These examples have not been thoroughly tested under all conditions. IBM, therefore, cannot guarantee or imply reliability, serviceability, or function of these programs.

© Copyright International Business Machines Corporation 2012. All rights reserved.
Note to U.S. Government Users Restricted Rights -- Use, duplication or disclosure restricted by GSA ADP Schedule Contract with IBM Corp.

This document was created or updated on May 24, 2013.

Send us your comments in one of the following ways:

- Use the online **Contact us** review form found at:
  ibm.com/redbooks
- Send your comments in an e-mail to:
  redbook@us.ibm.com
- Mail your comments to:
  IBM Corporation, International Technical Support Organization
  Dept. HYTD Mail Station P099
  2455 South Road
  Poughkeepsie, NY 12601-5400 U.S.A.

This document is available online at http://www.ibm.com/redbooks/abstracts/tips0886.html .

Trademarks

IBM, the IBM logo, and ibm.com are trademarks or registered trademarks of International Business Machines Corporation in the United States, other countries, or both. These and other IBM trademarked terms are marked on their first occurrence in this information with the appropriate symbol (® or ™), indicating US registered or common law trademarks owned by IBM at the time this information was published. Such trademarks may also be registered or common law trademarks in other countries. A current list of IBM trademarks is available on the Web at http://www.ibm.com/legal/copytrade.shtml.

The following terms are trademarks of the International Business Machines Corporation in the United States, other countries, or both:

Calibrated Vectored Cooling™
IBM Flex System™
IBM®
PowerPC®
PureFlex™
Redbooks®
Redbooks (logo)®
ServerProven®
ServicePac®
System Storage®
System x®

The following terms are trademarks of other companies:

Intel Xeon, Intel, Intel logo, Intel Inside logo, and Intel Centrino logo are trademarks or registered trademarks of Intel Corporation or its subsidiaries in the United States and other countries.

Linux is a trademark of Linus Torvalds in the United States, other countries, or both.

Microsoft, Windows, and the Windows logo are trademarks of Microsoft Corporation in the United States, other countries, or both.
Other company, product, or service names may be trademarks or service marks of others.